What is claimed is:

1. A magnetic memory apparatus comprising:

a patterned magnetic recording medium in which multilayered nanostructures each having a first magnetic layer, a nonmagnetic metal layer or a nonmagnetic insulating layer and a second magnetic layer laminated in that order on a conductive electrode layer formed on a substrate are laid out apart from one another at substantially even pitches; and

a cantilever array in which cantilevers having conductive chips at distal ends are laid out in an array and apart from one another in such a way as to be associated with said nanostructures, whereby information is written or read by a current supplied from that one of said conductive chips which is associated with a desired one of said nanostructures as that conductive chip is put in contact with said desired nanostructure.

2. A patterned magnetic recording medium in which pillar-like nanostructures each comprising a multilayered film showing a tunneling magnetoresistance effect or a multilayered film showing a giant magnetoresistance effect are surrounded by insulators in such a way as to be laid out apart from one another at substantially even pitches and are provided on a conductive electrode layer formed on a substrate.

3. A patterned magnetic recording medium in which pillar-like nanostructures each comprising a

multilayered film having a lamination of a multilayered film showing a tunneling magnetoresistance effect and a multilayered film showing a giant magnetoresistance effect are surrounded by insulators in such a way as to be laid out apart from one another at substantially even pitches and are provided on a conductive electrode layer formed on a substrate.

4. The magnetic recording medium according to claim 2, wherein said multilayered film showing said tunneling magnetoresistance effect comprises a multilayered film having a first magnetic layer, a nonmagnetic insulating layer and a second magnetic layer laminated in that order, said multilayered film showing said giant magnetoresistance effect comprises said second magnetic layer, a nonmagnetic metal layer and a third magnetic layer laminated in that order, and said second magnetic layer constituting said multilayered film showing said tunneling magnetoresistance effect serves as said second magnetic layer constituting said multilayered film showing said giant magnetoresistance effect.

5. The magnetic recording medium according to claim 2, further comprising means for fixing a direction of magnetization of one of magnetic layers constituting said multilayered film showing said tunneling magnetoresistance effect or said multilayered film showing said giant magnetoresistance effect to one direction.

6. The magnetic recording medium according to claim 4, further comprising means for fixing a direction of magnetization of said third magnetic layer to one direction.

7. The magnetic recording medium according to claim 5, wherein said means for fixing said direction of magnetization to one direction is an antiferromagnetic film.

8. A magnetic memory apparatus comprising:

a patterned magnetic recording medium in which nanostructures each comprising a multilayered film showing a tunneling magnetoresistance effect and/or a multilayered film showing a giant magnetoresistance effect are surrounded by insulators in such a way as to be laid out apart from one another at substantially even pitches and are provided on a conductive electrode layer formed on a substrate; and

a cantilever array in which cantilevers having conductive chips at distal ends are laid out in an array and apart from one another in such a way as to be associated with said nanostructures, whereby information is written or read by a current supplied from that one of said conductive chips which is associated with a desired one of said nanostructures as that conductive chip is put in contact with said desired nanostructure.

9. A magnetic recording method which uses a patterned magnetic recording medium in which

nanostructures each comprising a multilayered film showing a tunneling magnetoresistance effect and/or a multilayered film showing a giant magnetoresistance effect are surrounded by insulators in such a way as to be laid out apart from one another at substantially even pitches and are provided on a conductive electrode layer formed on a substrate, and a cantilever array in which cantilevers having conductive chips at distal ends are laid out in an array and apart from one another in such a way as to be associated with said nanostructures, and writes digital information by inverting magnetization with 1 being a state where a resistance of said multilayered film is high while 0 is a state where said resistance is low, using a current supplied from that one of said conductive chips which is associated with a predetermined one of said nanostructures as that conductive chip is put in contact with said predetermined nanostructure.

10. A signal reading method which uses a patterned magnetic recording medium in which nanostructures each comprising a multilayered film showing a tunneling magnetoresistance effect and/or a multilayered film showing a giant magnetoresistance effect are surrounded by insulators in such a way as to be laid out apart from one another at substantially even pitches and are provided on a conductive electrode layer formed on a substrate, and a cantilever array in which cantilevers having conductive chips at distal

ends are laid out in an array and apart from one another in such a way as to be associated with said nanostructures, and detects a level of a resistance of each multilayered pillar by putting that one of said conductive chips which is associated with a predetermined one of said nanostructures in contact with said predetermined nanostructure and causing a current whose value is smaller than that of a current by which magnetization of said multilayered film is inverted to flow from said conductive chip.

11. A method of fabricating a patterned magnetic recording medium in which nanostructures each comprising a multilayered film are surrounded by inorganic insulators in such a way as to be laid out apart from one another at substantially even pitches and are provided on a substrate by performing, in order, the steps of:

forming a multilayered film showing a tunneling magnetoresistance effect or a multilayered film showing a giant magnetoresistance effect;

forming a resist pattern on said multilayered film;

etching said multilayered film using said resist pattern as a mask;

removing said resist pattern;

forming an inorganic insulating film on said etched multilayered film; and

planarizing said inorganic insulating film by chemical mechanical polishing (CMP),

12. The method according to claim 11, wherein said step of forming said resist pattern has the step of using a die in which a predetermined pattern is formed in advance on another substrate different from the one on which said resist pattern is formed.